

SDIO Long Wavelength Infrared Detector Requirements

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The Strategic Defense Initiative Organization has a significant requirement for infrared sensors for surveillance, tracking and discrimination of objects in space. Projected SDIO needs cover the range from short wavelengths out to 30 μm . Large arrays are required, and producibility and cost are major factors. The SDIO is pursuing several approaches including innovative concepts based on semiconductors and superconductors.



SDIO INFRARED TECHNOLOGY EFFORTS

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SENSORS AND INTERCEPTORS DIRECTORATE

MARCH 13, 1990



AGENDA (U)

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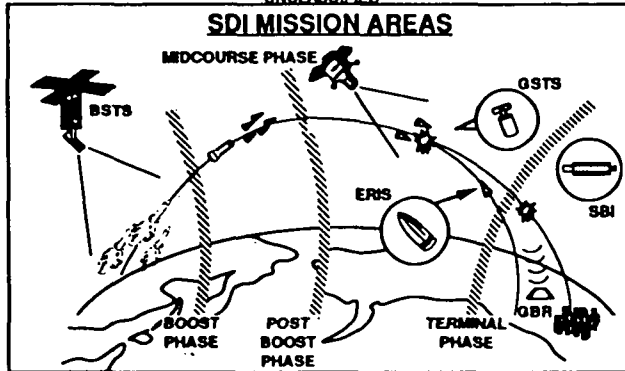
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- SCOPE OF SDIO IR SENSOR TECHNOLOGY DEVELOPMENT
- TECHNOLOGY THRUSTS
 - OPTICS TECHNOLOGY
 - FOCAL PLANE TECHNOLOGY
 - CRYO COOLERS
 - SIGNAL PROCESSORS
 - INTEGRATED SENSORS
- SUMMARY



SCOPE OF SDIO IR SENSOR TECHNOLOGY (U) (U)

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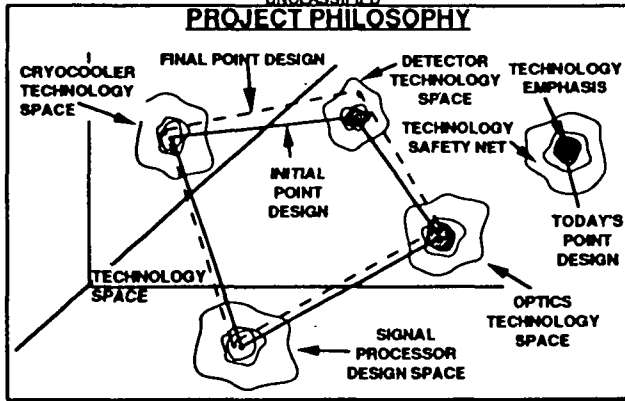
PROJECT 5 MISSION

- DEVELOP IR TECHNOLOGY NECESSARY TO SUPPORT SDI SURVEILLANCE AND WEAPON SYSTEM SENSORS FOR PHASE I
- ADVANCE THE STATE OF ART FOR IR SENSORS

AGENTS

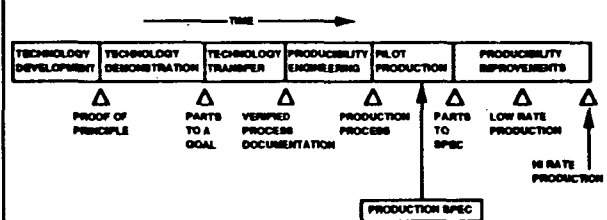
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TECHNOLOGY MATURITY



CRYOCOOLERS (U)

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DRIVERS

HIGH RELIABILITY
EXTEND ON-ORBIT LIFETIME
HIGH EFFICIENCY
LOW WEIGHT
ACCUMULATE OPERATING HISTORY
REDUCE COST

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CURRENT APPROACH

TURBO-BRAYTON(3-STAGE)
ROTARY RECIPROCATING REFRIGERATOR (R-3 STAGE)
2-STAGE LIFE TESTING
DEVELOP THERMAL INTEGRATION TECHNOLOGIES (HEAT PIPE, THERMAL SWITCH)

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NEW TECHNOLOGY

MAGNETIC COOLING
SORPTION COMPRESSION
MIXED GAS QUICK COOLDOWN J-T
PULSE TUBES
ACOUSTIC DRIVERS

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NEEDS

HARDENED FLIGHT CONTROL ELECTRONICS
REDUCED WEIGHT HIGH EFFECTIVENESS HEAT EXCHANGERS
MODULAR/SCALEABLE CRYOCOOLERS
SOLID STATE CONCEPTS

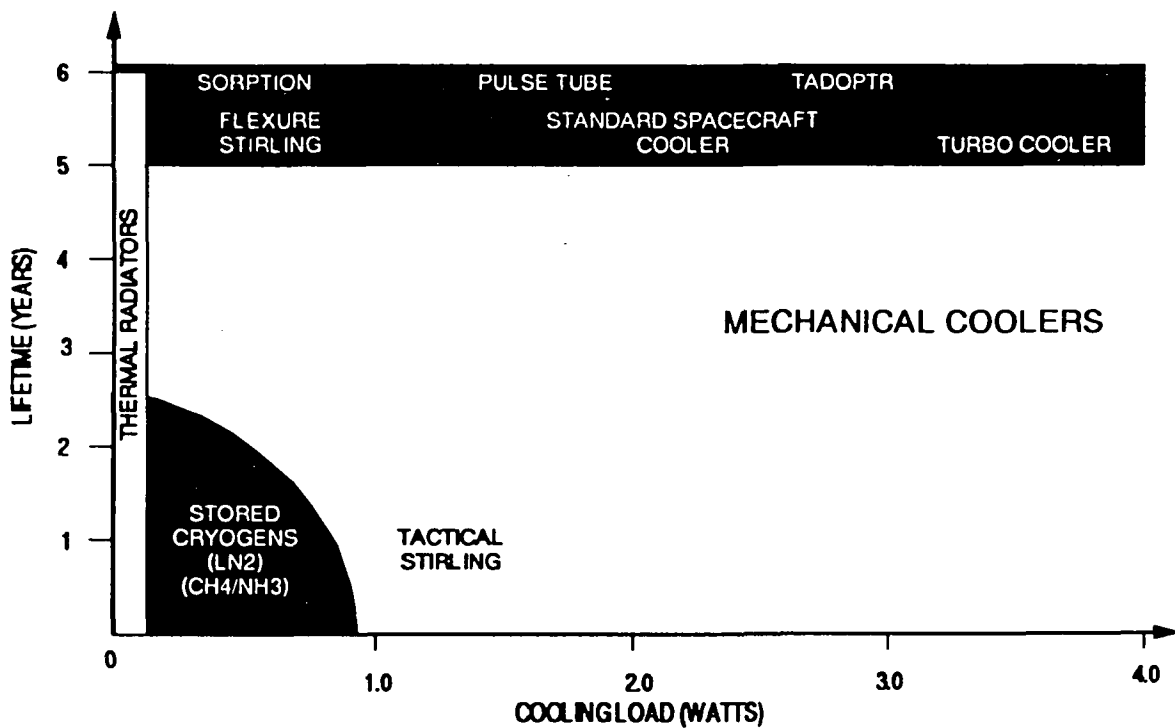
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CRYOGENIC TECHNOLOGY PARAMETERS



ASSUME COOLING TEMPERATURE 65-80K

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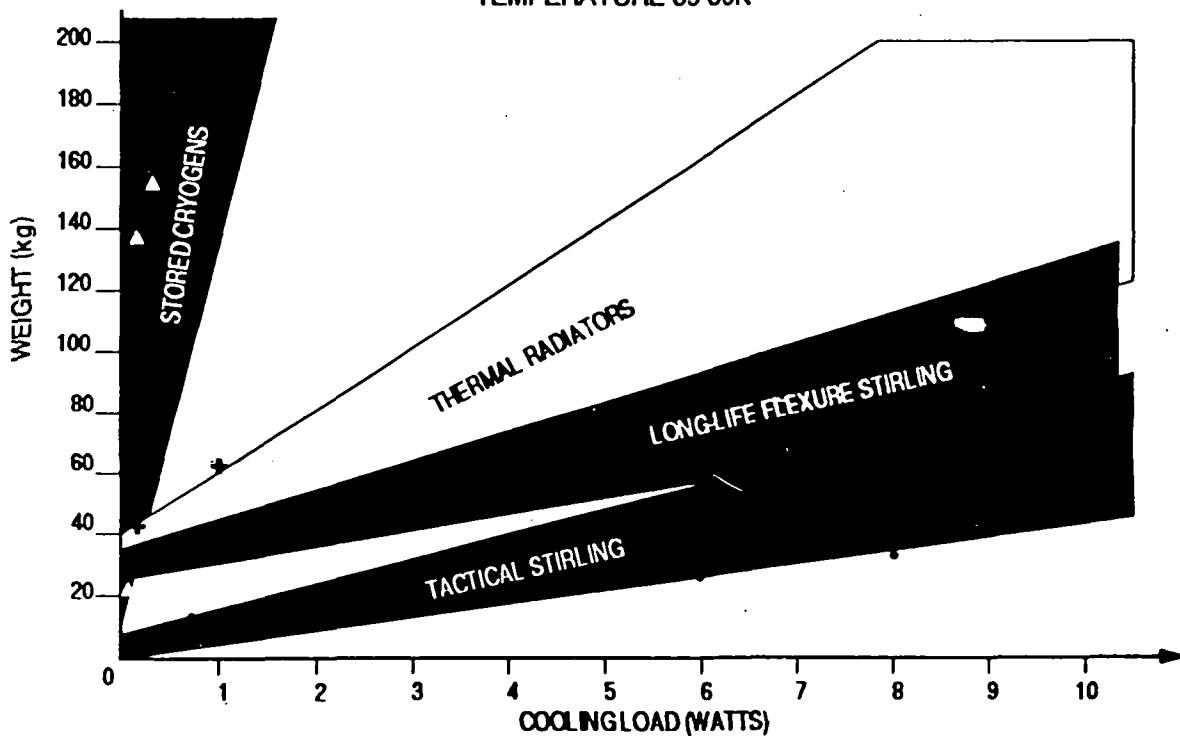
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CRYOGENIC SYSTEM WEIGHT



TEMPERATURE 65-80K

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FOCAL PLANE ARRAY TECHNOLOGY (U)

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<u>DRIVERS</u>	<u>DRIVING SYSTEM</u>
• YIELD/COST/ PRODUCIBILITY	KEW, GSTS
• RADIATION HARDNESS	KEW, SSTS
• OPERATING TEMPERATURE	SSTS
• HYBRID PERFORMANCE	SPIRIT III, SSTS, GSTS
• D*	SSTS, GSTS
• CUTOFF WAVELENGTH	SSTS, GSTS
• UNIFORMITY	SPIRIT III, GSTS, SPIRIT III, SSTS, GSTS
• CROSSTALK	

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<u>CURRENT APPROACH</u>
• MANTECH – MWIR PILOT LINE DEMO FOR BOOST PHASE APPLICATION
• HYWAYS – IBC HYBRID DEVELOPMENT FOR SSTS, GSTS – ADVANCED HYBRID DEVELOPMENT – PILOT LINE DEMO
• SLIM – LWIR HgCdTe FOR KEW & SSTS BACKUP
• HARDENED INSB TECHNOLOGY FOR SCANNERS

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<u>NEW TECHNOLOGY</u>
• INTRINSIC EVENT DISCRIMINATOR
• SOLID STATE PHOTOMULTIPLIER
• Ge CTIA
• GeAs MUX FOR HgCdTe
• HIGH OPERATING TEMPERATURE DETECTORS
• HIGH TEMPERATURE SUPERCONDUCTORS
• STRAINED LAYER SUPERLATTICE
• VLWIR HgCdTe – HIT DETECTORS, SOFRADIR
• LWIR Hg CdTe TECHNOLOGY
• HgCdTe PASSIVATION TECHNOLOGY

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<u>NEEDS</u>
• MODULES
• NOISE MODELS FOR HYBRID INTEGRATION
• LARGER SUBSTRATES
• AUTOMATED TESTING FACILITY
• TRAINING FOR TEST FACILITY PERSONNEL
• INTEGRATED FOCAL PLANE TECHNOLOGY



IRFPA DESIGN DRIVERS (U)

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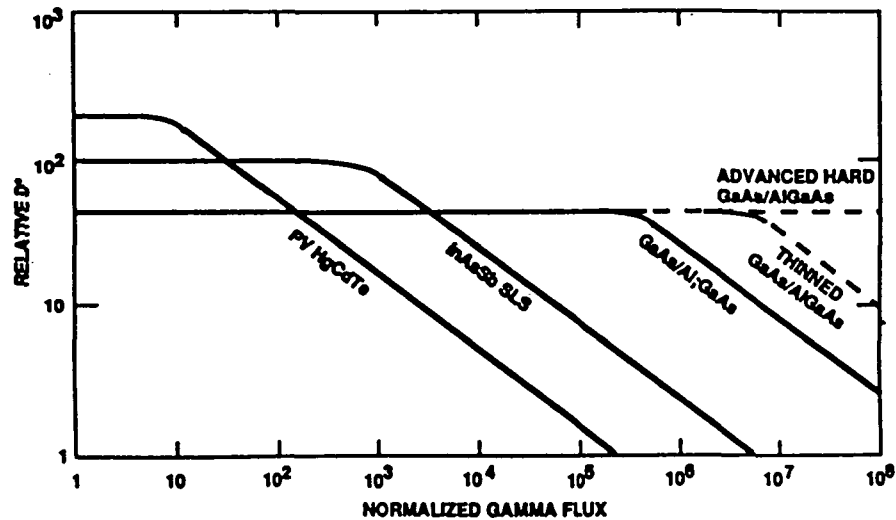
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- LOW TEMPERATURE TARGETS
- LOW BACKGROUNDS
- HIGH TOTAL DOSE ENVIRONMENT
- 3 COLORS REQUIRED FOR DISCRIMINATION
- LARGE FOV – HIGH SCAN RATES
 - SHORT INTEGRATION TIMES
 - HIGH DATA RATES FOR ANALOG SIGNAL PROCESSOR
- LARGE NUMBERS OF TARGETS/DECOYS
- HIGH THROUGHPUT REQUIREMENTS FOR OBJECT DEPENDENT PROCESSORS



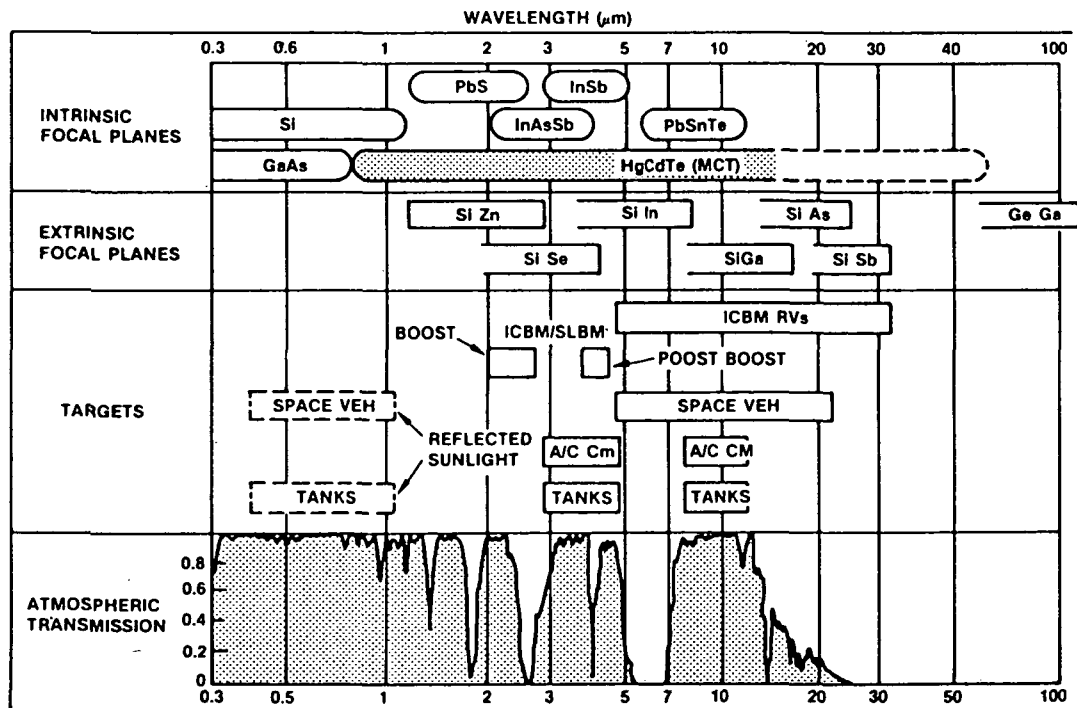
RELATIVE HARDNESS

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MATERIALS/APPLICATIONS MATCH-UPS (U)

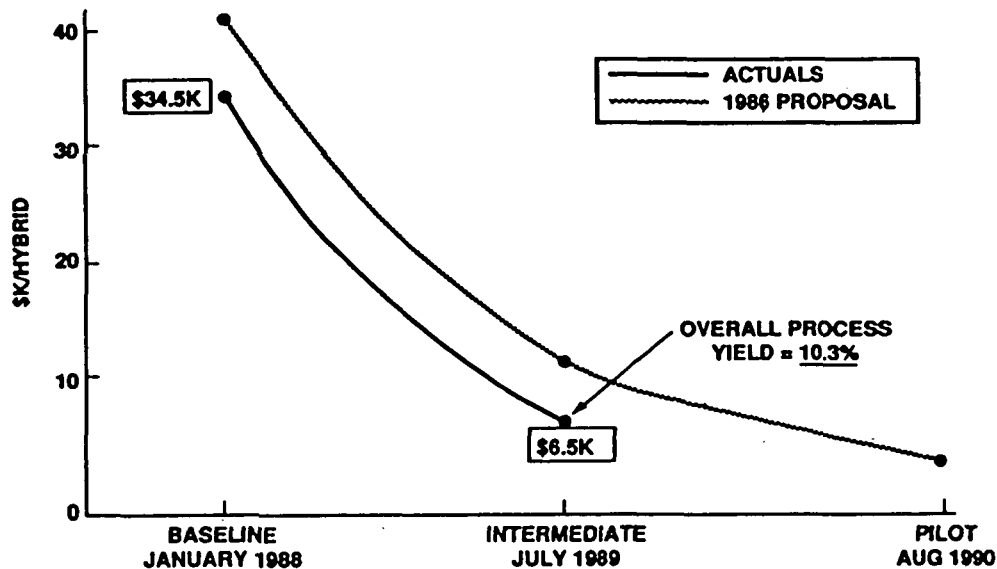
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80% COST REDUCTION DEMONSTRATED WITH INTERMEDIATE RUN



MANTECH STATUS (U)

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• ORIGINAL	CONFIGURATION	YIELD	YIELD GOAL	COST/HYBRID	COST GOAL
— ROCKWELL (HYBRIDS)	32x8	0.2	—	\$100 K	—
— SBRC (DETECTOR ARRAYS)	32x8	0.2	—	\$200 K	—
• BASELINE RESULTS					
— ROCKWELL (HYBRIDS)	32x64	1.35%	0.4%	\$34 K (100% TEST)	\$20/CHANNEL
— SBRC (DETECTOR ARRAYS)	128x128	3.5%	0.4%	\$15 K (SAMPLE TEST)	\$20/CHANNEL
• INTERMEDIATE RESULTS					
— ROCKWELL • YIELD 2X BASELINE	32x64	10.3%	1.5%	\$6.5 K	\$5/CHANNEL (\$3.16 ACHIEVED)
— SBRC • YIELD/PERFORMANCE IMPROVEMENTS • CdTe PASSIVATION	128x128	35% PRO- JECTED	1.5%	\$4.6 K (SAMPLE TEST)	\$5/CHANNEL (\$0.28 PROJECTED WITH SAMPLE TESTING)

OF PIXELS WORKING MADE UNDER MANTECH = >3M

OF PIXELS REQUIRED BY END OF CONTRACT = ~2M

ISSUES REMAINING AFTER MWIR HgCdTe MANTECH (U)

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<u>ISSUE</u>	<u>NEED TO BE ADDRESSED BY</u>
• HARDNESS	TECHNOLOGY PROGRAM MANTECH REVISITED
• PRODUCIBILITY OF NUCLEAR HARD ARRAYS	
• INTERGRATION OF ARRAYS	TECHNOLOGY OR PRIMES
• UNIFORMITY	TECHNOLOGY DEVELOPMENT
• SUSTAINING MARKET PLACE	TATICAL?
• TRUE HANDOFF TO PRODUCTION WITH LESS TOUCH LABOR	DPESO/DSTAR
• THIRST FOR HIGHER PERFORMANCE AT LOWER COST	TECHNOLOGY MATERIALS/ DSTAR LABOR
• RADIOMETRY PERFORMANCE	TECHNOLOGY
• READOUTS	TECHNOLOGY



BENEFITS OF IBC DETECTORS (U)

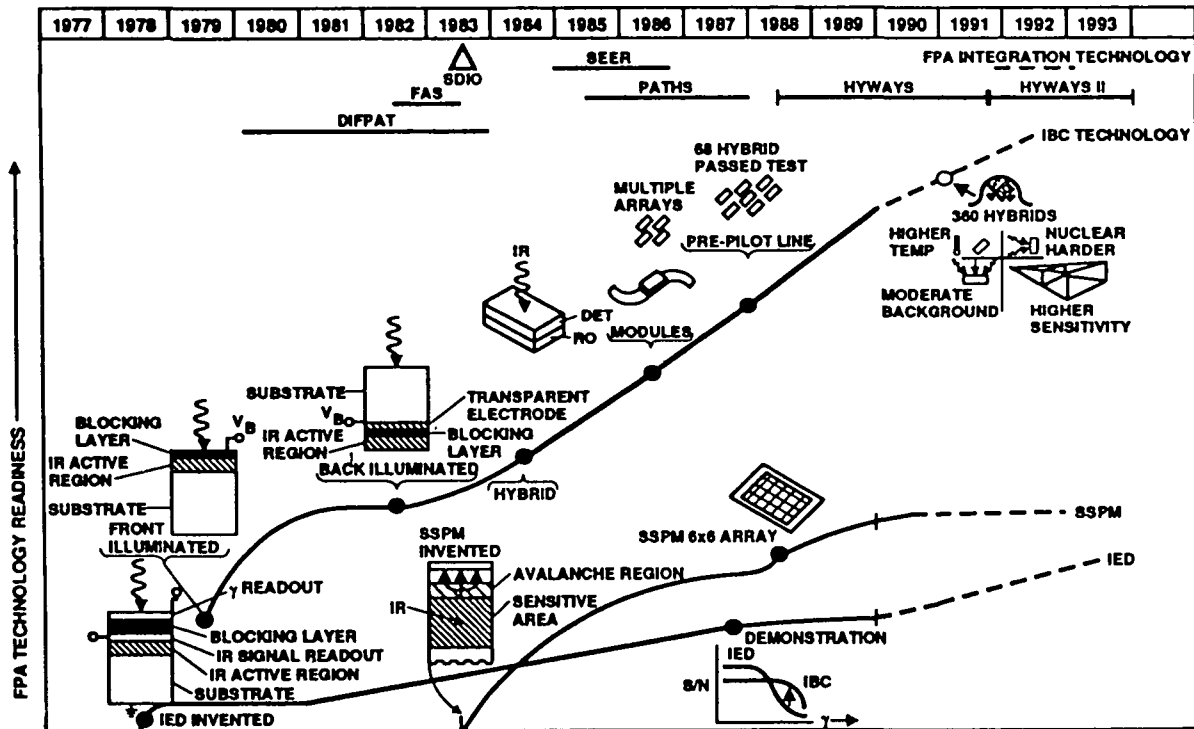
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- RADIATION HARDNESS
- RESPONSE LINEARITY
- FREQUENCY OF RESPONSE
- UNIFORMITY OF RESPONSE
- PREDICTABLE BEHAVIOR
- HIGH RESPONSIVITY
- RELATIVELY HIGH PIXEL YIELD



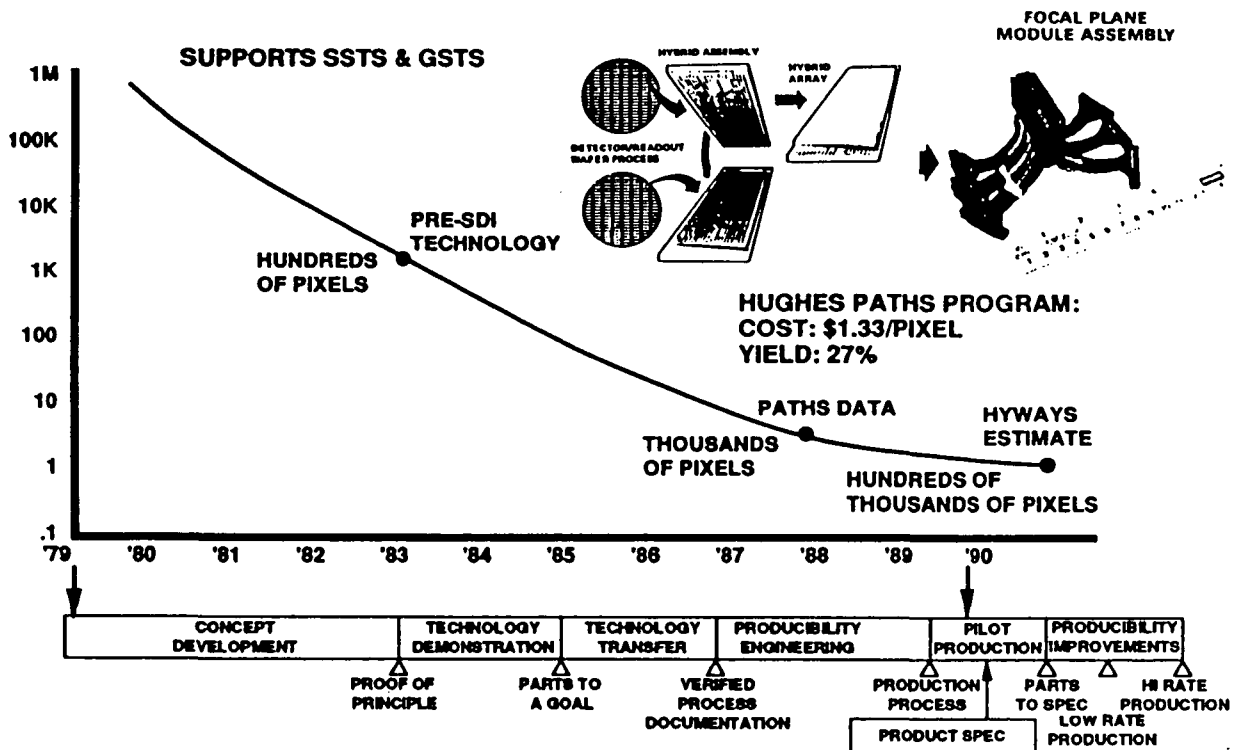
IBC FOCAL PLANE DEVELOPMENT (U)

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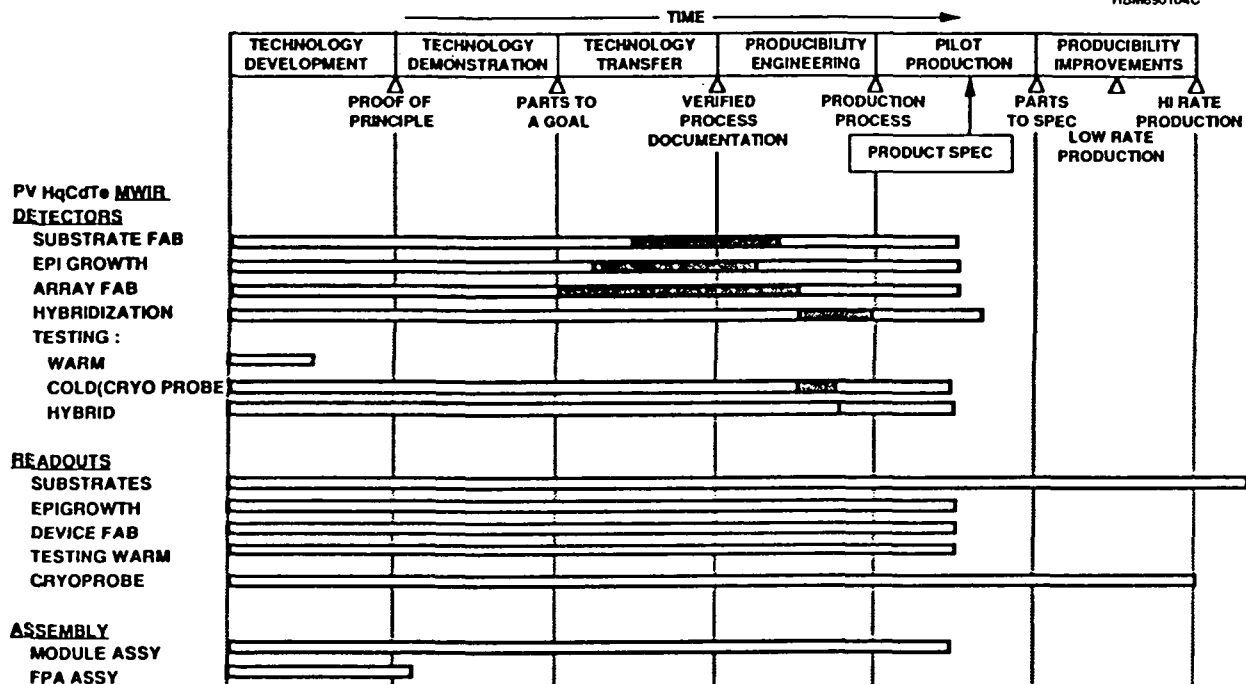
VLWIR TECHNOLOGY NEARS PILOT PRODUCTION (U)

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IR SENSOR COMPONENTS STATUS ON TECHNOLOGY CYCLE MODEL(U)

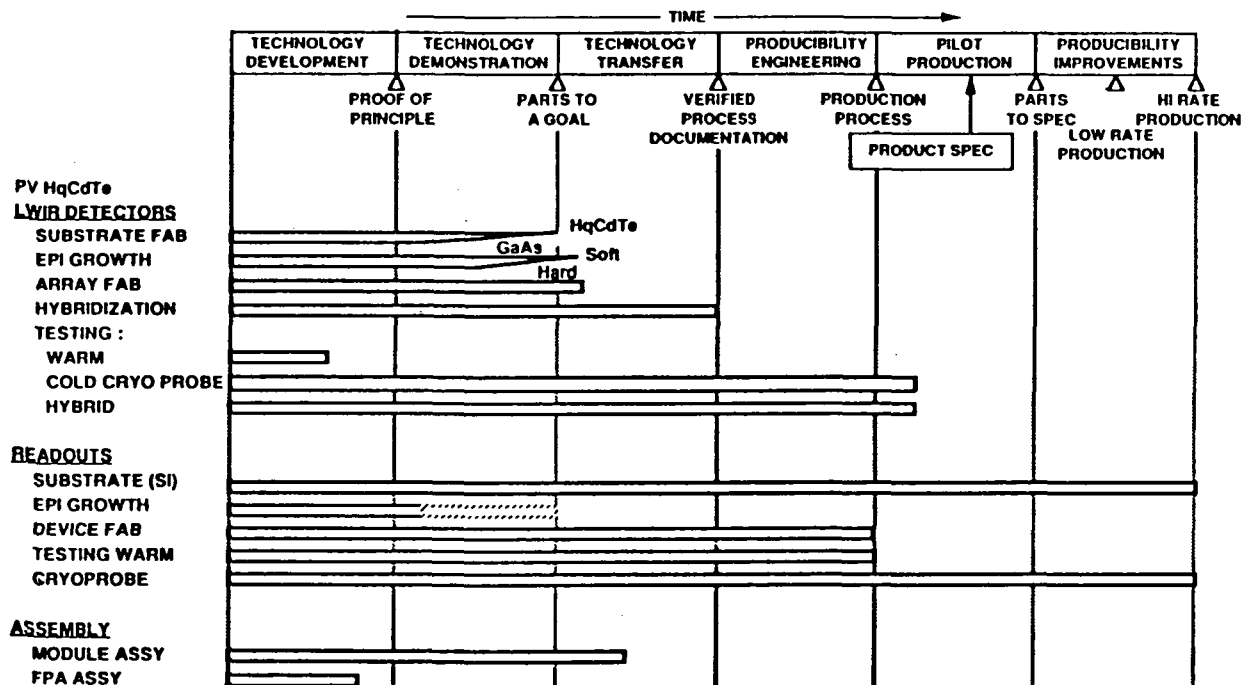
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MANTECH OBJECTIVES

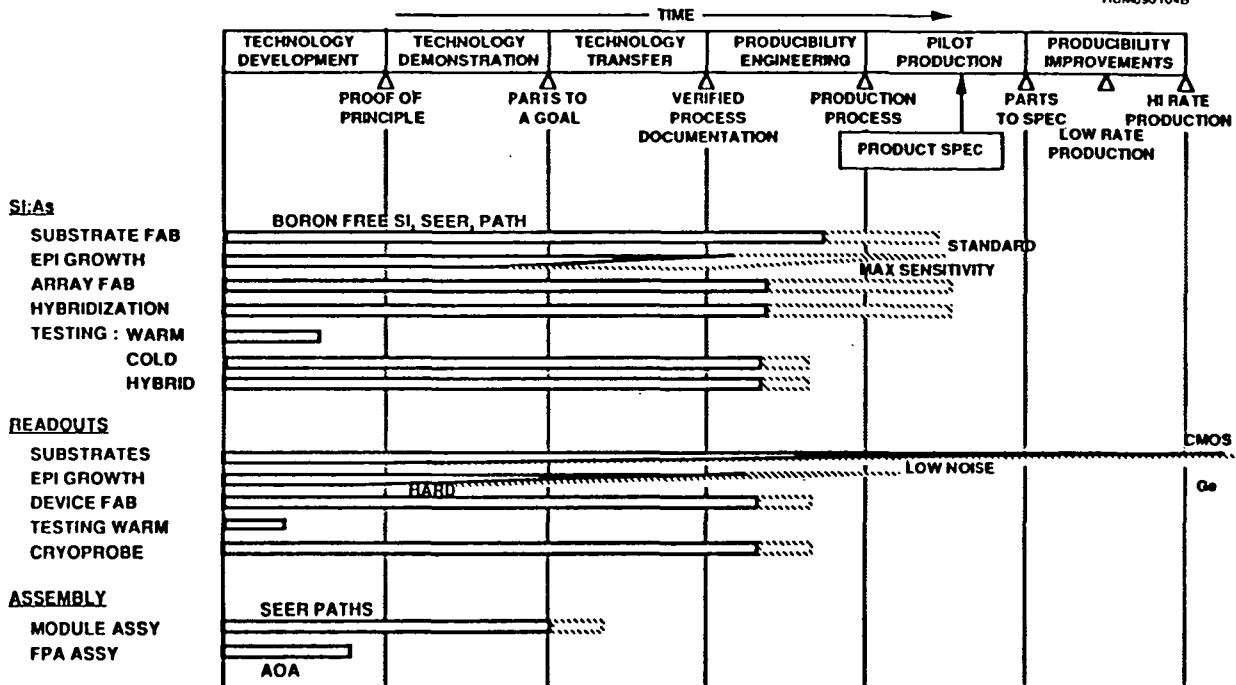
PHASE I

PHASE II



IR SENSOR COMPONENTS STATUS ON TECHNOLOGY CYCLE MODEL(U)

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FUTURE PLANS (U)

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- NEAR TERM
 - HYWAYS - ADVANCED HYBRIDS FOR ENHANCED RADIATION TOLERANCE, HIGHER SENSITIVITY, LOWER NOISE
 - HYWAYS - ENHANCED PRODUCTION RATES
 - DECISION ON CONTINUATION OF Si:Ga
- MID-TERM
 - IED PERFORMANCE IMPROVEMENTS
 - EXTENDED WAVELENGTH RESPONSE
 - MICROLENSSES
 - APPLICATION OF IBC TECHNOLOGY TO INTERCEPTOR REQUIREMENTS
 - HIGHER OPERATING TEMPERATURE
- FAR TERM
 - EXPLORE IBC CONCEPT IN OTHER MATERIALS AND DEVICES
 - ADDRESS IED/SSPM PRODUCIBILITY

CONCLUSION

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- **TECHNOLOGY PROGRAMS ARE PLANNED TO ENCOMPASS SYSTEM NEEDS FOR DETECTOR/READOUT PERFORMANCE AND AVAILABILITY**
- **TECHNOLOGY PROGRAMS OR SYSTEM PROGRAMS MUST ADDRESS FPA INTEGRATION ISSUES**
- **HARDNESS IS THE LAGGING TECHNOLOGY**
- **HARDNESS IS SUFFICIENT FOR SPACE DEMO PROGRAM**